TETA TO-OO15
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TEST EFFECTIVENESS TREND OBSERVATION

Closure Time for Design Related PFRs

CONCLUSION:

The closure time for design-related problem/failure reports (PFRs), the elapsed time interval between the opening and closing of the PFRs, increased with chronological S/C development for JPL in-house programs-- going from Mariner 71 to Galileo. A possible inference from this is that the increase in S/C complexity leads to a greater required effort to close out the problem/failures; thereby increasing the importance of design-related reliability analyses and timely independent reviews of them. A concurrent engineering concept currently being implemented which involves the reliability engineer in parallel with the problem identification/resolution rather than in series is expected to significantly reduce closure time. Another possible source of the longer closure times for the more recent programs is a classical example of Parkinson's Law (work expands to fill the time available), resulting from the stretch-out of launch dates for the Galileo project.

DISCUSSION:

The closure time, as defined above, for design related problem/failure reports (PFRs) was investigated for four flight projects: Mariner 71, Viking Orbiter, Voyager and Galileo. Many PFRs lead to significant analytical studies or testing of spacecraft hardware to determine the cause of the problem/failure. The process can be both time consuming and costly. The elapsed time between the opening and closing of a PFR relates to the effort involved and the ability to satisfactorily resolve the issue. Therefore, the study, described in this Trend Observation, was undertaken to determine the distribution of closure times for four flight projects.

The specific problems considered include: design specification; functional application; and misapplication. The problems were selected for analysis because they are significant to reliability analyses and their review.

Figure 1 provides a composite of the distributions of closure times for the four flight programs, as a percentage of the total PFRs, on a per unit of closure time interval (in days), versus closure time for the design related PFRs in the categories cited above. Figure 2 provides the same composite for PFRs selected from the same population with a failure effect rating of significant or catastrophic (JPL failure effect rating 2 or 3). The distribution curves have been smoothed out to eliminate most of the short-interval fluctuations.

The average time for closure of significant design related problem/failures, was usually greater than that of the average time for all PFRs (Compare Figures 1 and 2). This is to be expected since these PFRs are associated with the more serious problems.

The distributions of percentage of PFRs with given closure times mostly had asymmetric distributions, some with sharp peaks, and relatively long tails. The tail of the Galileo distributions was about three times longer than for the other three flight programs, complimenting a shift in the peak of the distribution. In general, the distributions of all-PFR closure times, were more sharply peaked than the distributions for PFRs rated significant.

The peaks of the distributions for all design related PFRs was about 70-75 days for Mariner 71, Viking and Voyager. For those PFRs with a significant failure-effect rating, the peak time remained the same for Mariner 71 and shifted to 125 days for the other two programs. For Galileo the peaks occurred at 150 days for all PFRs and at 250 days for the PFRs rated significant.

A possible inference from Figures 1 and 2 is that the increase in S/C complexity leads to a greater effort required to close the problem/failure reports. This emphasizes the importance of timely reviews of reliability analyses or a concurrent engineering approach to performing reliability analyses.

This trend report suggests a follow-on report dealing with the development of a metric for measuring improvements in closure time. This metric could consist of a parametric representation of closure time including some or all parameters such as averages, SD's, time distribution characteristics, with normalization factors accounting for such things as significance of the problem/failure, number of project disciplines involved in resolving the problem, phase of the mission where the anomaly occurs, etc. This metric might then be used to measure improvements in the ability to close PFRs resulting from project changes such as concurrent engineering.

DISTRIBUTION OF CLOSURE TIMES FOR DESIGN RELATED PFRS FOR MARINER 71-GALILEO

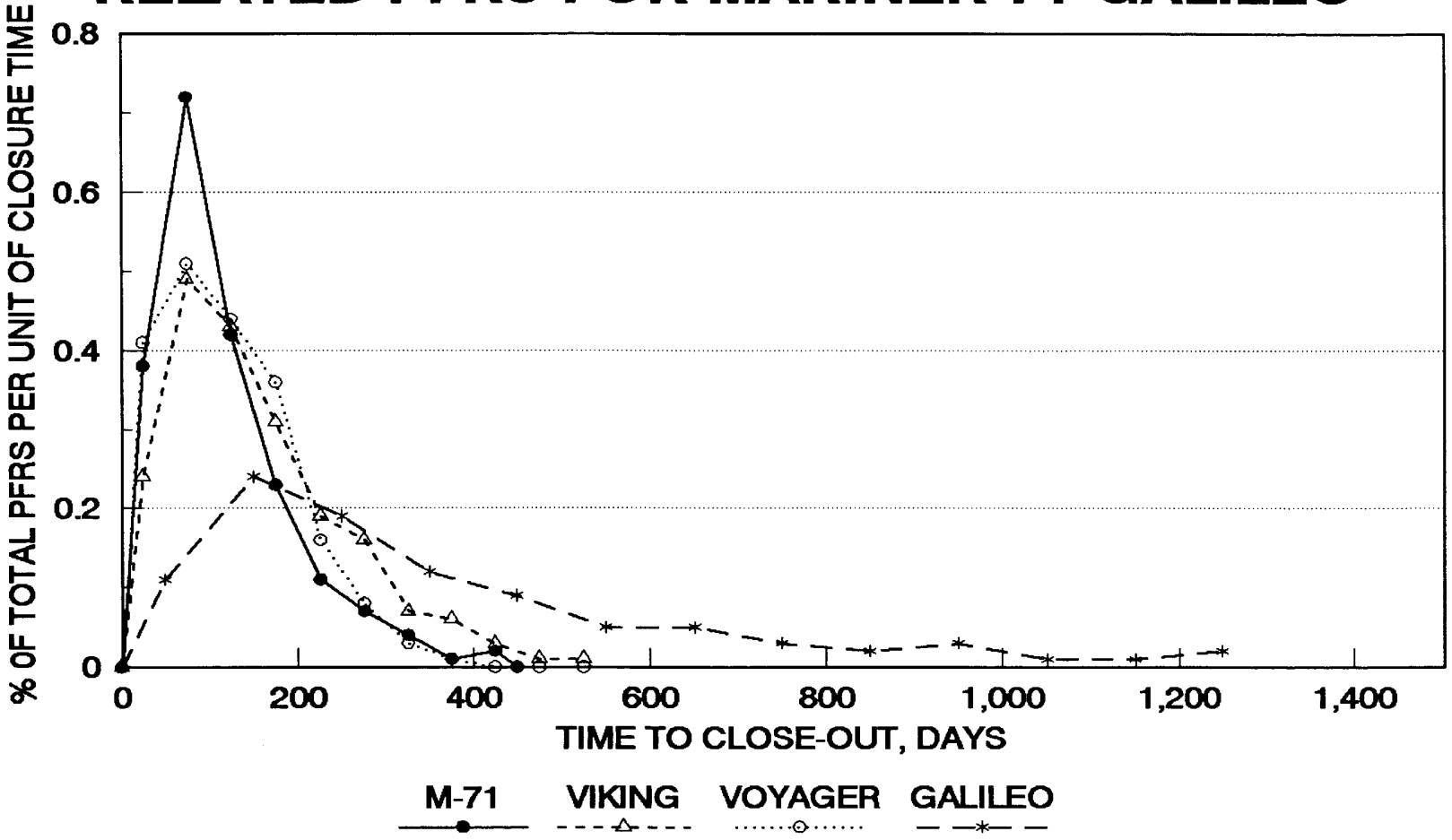

FIGURE 1

DISTRIBUTION OF CLOSURE TIMES FOR DESIGN RELATED SIGNIFICANT PFRS FOR MARINER 71-GALILEO

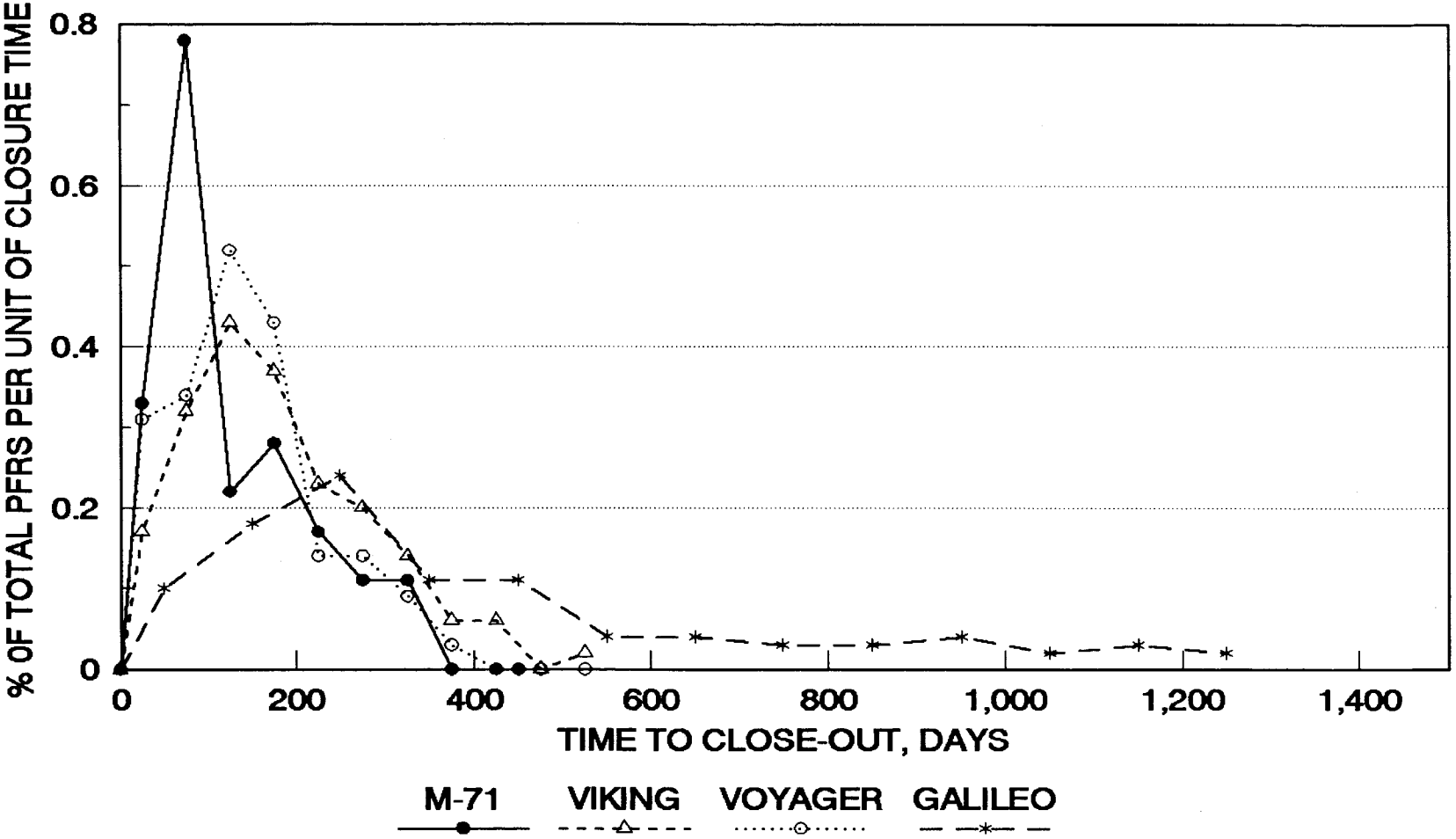

FIGURE 2